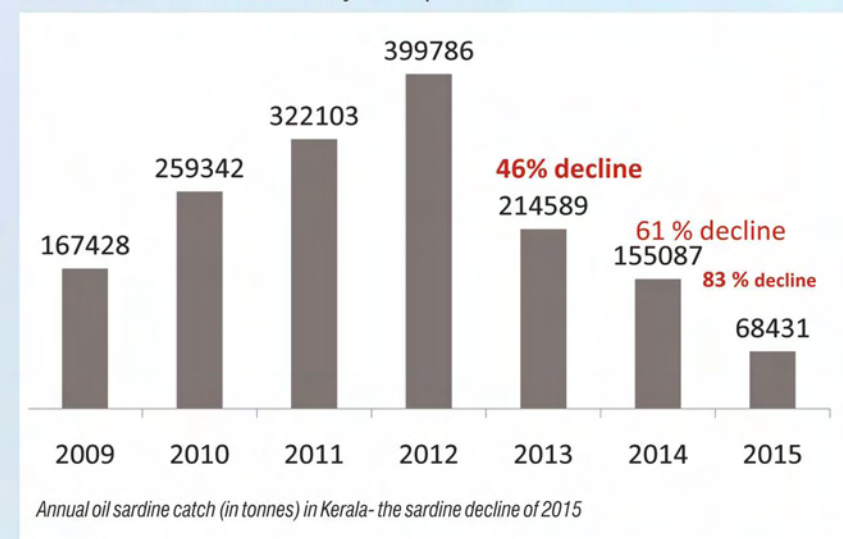


Kripa, V*, Shelton Padua, Jeyabaskaran R., D.Prema, Said Koya KP, Mohamed KS, Divya ND, Preetha G Nair, Dhanya AM, Shara AS, Abhilash KS, Ambrose TV, John Bose and Vishnu
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Background

- The coastal upwelling zone off Kerala is one of the major habitats of the Indian oil sardine, *Sardinella longiceps*.
- The sardine fishery of Kerala declined to 46,000 tonnes in 2016 from an all-time peak of 3.99 x 105 tonnes in 2012.
- The reasons for decline in sardine fishery, were found to be due to fishery dependent and independent factors (Kripa et al., MS)
- It was observed that the sardine habitat temperature had increased and the phytoplankton density was also low in 2015. This inference based on real-time observations was considered as a 'drought like situation in the sea'.
- Since it is difficult to collect real time data from all fishing zones, application of remote sensed data to identify such episodes is needed.



Objectives

- Analyse whether the ecological changes observed in the sardine habitat off Kerala using real –time (in situ) measurements were reflected in the remote-sensed SST and Chlorophyll a values.
- Evaluate whether this abiotic stress affected the biological functions of sardine.
- Explore the possibilities of using remote sensing for identifying shortterm "oceanic droughts" in the sea

Why this study is important ?

- The above normal temperature episodes in land have been termed as droughts for terrestrial ecosystems while aquatic ecosystems have no clear cut criteria to classify above normal SST affecting primary production as oceanic or sea drought.
- When fishery declines due to natural disasters fishermen are not given financial support as drought relief fund since there is no "drought" in the sea recognized.

Livelihoods affected

- Sardine decline led to an estimated loss of Rs 150 crore (CMFRI, 2016)
- Employment dropped by 28.2% Loss of US\$ 22.2 Million
- Price of sardine increased on average by 60%

Material and methods

Sampling Area



Real time data on Ecology

- SST was recorded from four stations off Kochi at 5, 10, 20 and 30m depths using Nansen bottle.
- Phytoplankton samples were collected from the above sites using standard plankton net

Remote Sense Data

Downloaded from <http://oceandata.sci.gsfc.nasa.gov/MODISA/Mapped>
 Mapping Monthly Averaged
 Resolution 4km

Biology -Methodology

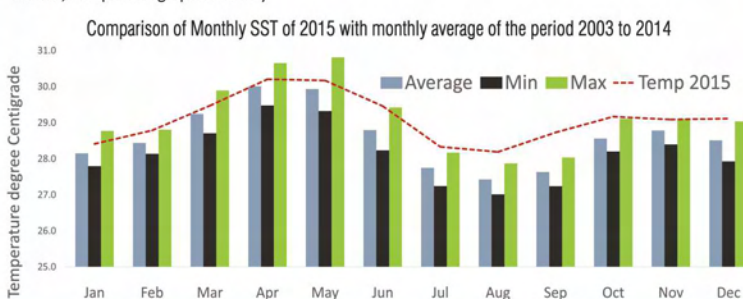
- Indian oil sardine samples from the ring seine catches were collected at fortnightly / weekly intervals
- Stomach fullness- each fish was dissected and based on the state of distension, the stomach was classified as empty, 1/4 full, 1/2 full, 3/4 to full and Gorged.

Results and Discussion

Remotely sensed SST

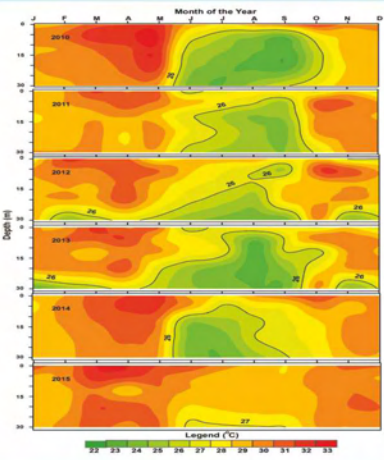
The SST during 2015 was higher than monthly average of the period 2003 to 2014 in all the months. 2015 the SST values were higher than the maximum values recorded for each month, except during April and May

The average SST was $28.6 \pm 0.18^\circ\text{C}$ during 2003 - 2014. The SST in 2015 ranged between 30.2°C and 28.1°C with an average of 28.09°C indicating an average difference of 0.49°C .



Temperature variation in sardine habitat-real time values.

- The analysis indicated that high SST prevailed in sardine habitat during 2015.
- The average seawater temperature in sardine habitat was 29.8°C during 2015, which is nearly 1.1°C higher than the avg observed (28.6°C) for the last 5 years (Kripa et al., MS)



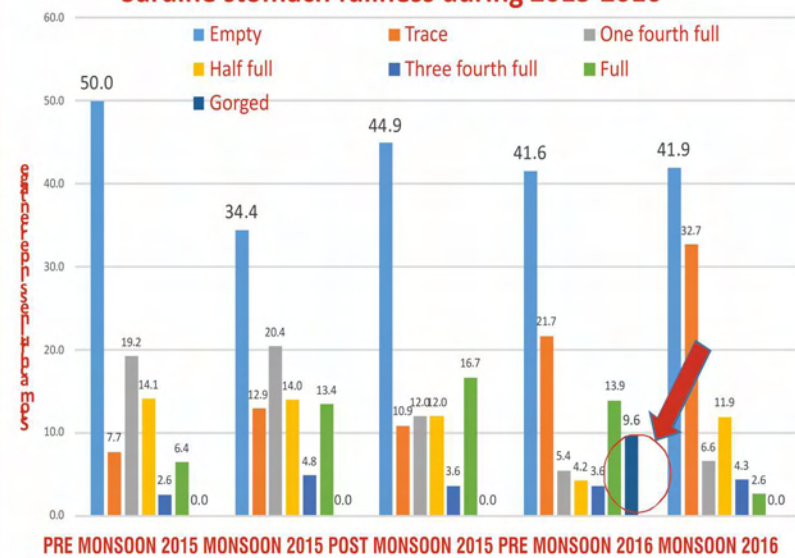
Phytoplankton density in sardine habitat

Food is one of the major factors affecting growth, maturity, recruitment and survival. During 2015, the food available was found to be extremely low. This may be due to El Nino of 2015-16. This glut was found to affect maturation and spawning in 2015 (Kripa et al MS).

How the low food availability was reflected in sardines off Kochi

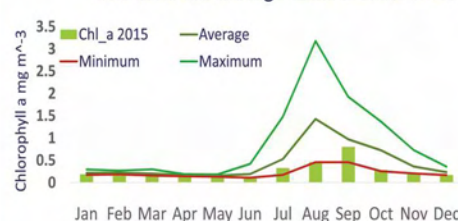
- Sardines are planktivorous with main food item being diatoms.
- Sardine guts were either 'empty' or only 'one fourth full' during the period 2015.
- This also indicates that "drought" like situation affected the sardines.

Sardine stomach fullness during 2015-2016

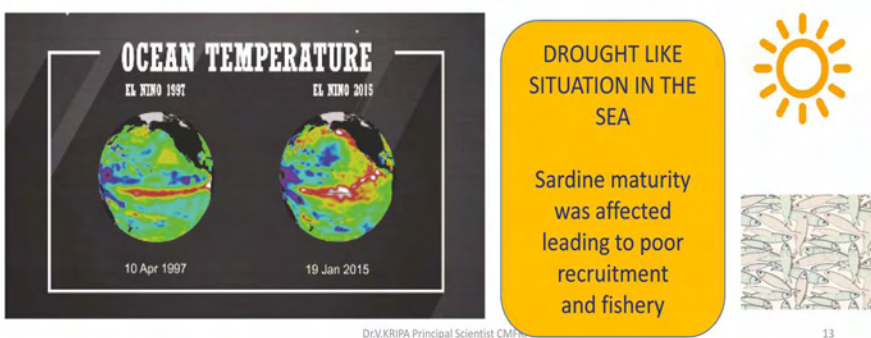
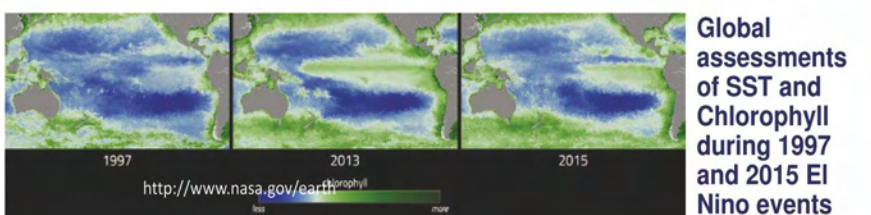
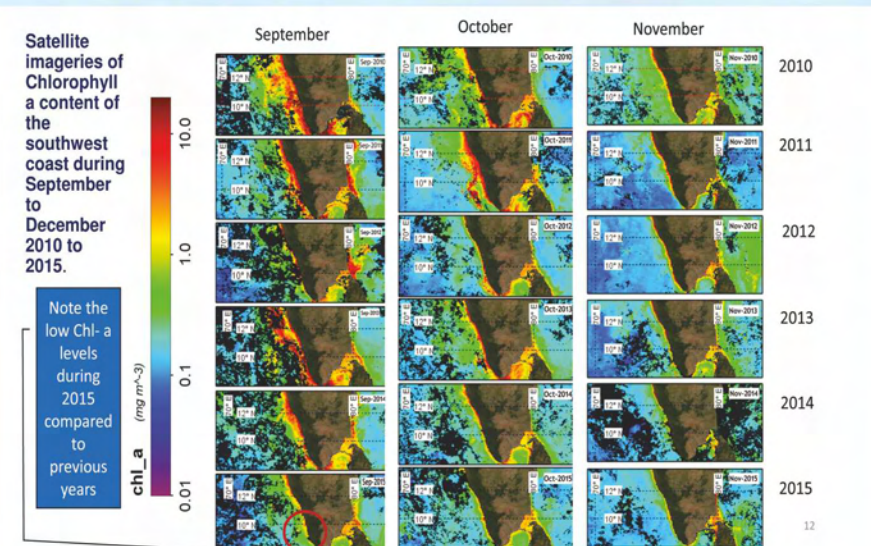
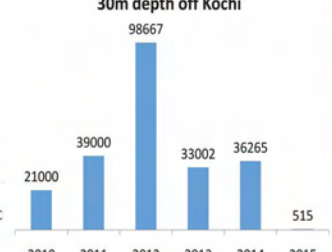


Similarly, the remote sensed Chlorophyll a data which gives an indication of the food available for the sardine was also considerably low, (0.27 mg m^{-3}) compared to 2003-2014 period ($0.47 \pm 0.09\text{ mg m}^{-3}$).

Comparison of monthly 2015 Chlorophyll a data with the average value of 2003 -2014

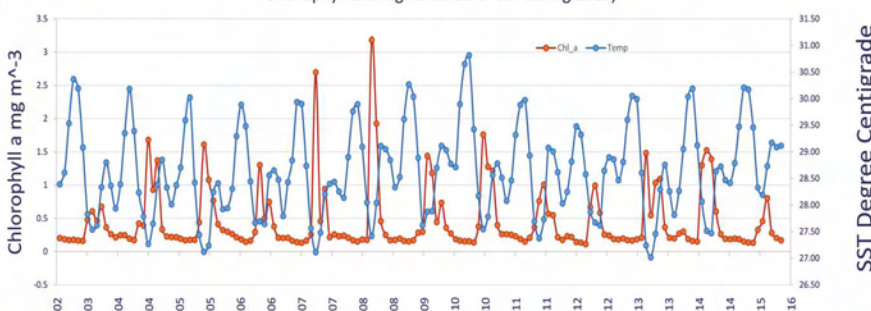


Average Phytoplankton (cells per litre) during April/May in the sardine habitat between 5m and 30m depth off Kochi



Short term drought in the coastal waters

Decadal variation in Chlorophyll and SST values off Kochi (Note- the persistently low levels of Chlorophyll and higher levels of SST during 2015)



In the present study, the remotely sensed SST and Chlorophyll a data were found to reflect the *in situ* observations on sardine habitat changes off Kochi.

This combination of high SST and low food supports the real time observations and can be considered as **short term drought in the coastal waters**

Conclusion and the way forward

- New Term –Oceanic / Sea Drought : Considering the fact that stressful environmental conditions of coastal waters severely affected the biota which in turn affected the fishery and the livelihoods of fishers, we propose the term 'Oceanic Drought' or 'Sea Drought' to indicate the condition like above normal SST and below normal chlorophyll a in the ocean as observed during 2015.
- Research Need: There should be more detailed studies to identify such drought affected areas using remote sensing and validating it through real time phytoplankton density and biological changes of planktivorous fishes which form large biomasses like the sardines.

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